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15 November 1968

MEMORANDUM FOR: Deputy for Operations, OSA

SUBJECT : "H" Camera

1. Recent missions with the "H" camera against coastal targets of Southeast China have produced photography whose scale and ground resolution were insufficient for target identification. Although the camera performed well and the missions were flown according to plan, the slant range (35 to 45 nautical miles) and the presence of clouds and haze degraded the imagry to an unacceptable degree.

2. While this problem is not a new one, it is one that we have given a considerable amount of attention to in an effort to improve the photographic results. The camera at present is being operated at 1/500 second exposure using 3400 film and a wratten 12 filter. A wratten 21, orange or wratten 25 filter could be used, but flight tests using 21 and 25 filters showed no improvement over the #12 filter and there are two disadvantages to using #21 or #25 filters: (1) the exposure time must be increased to compensate for the greater density (light transmission value) of these filters, thus causing a greater risk of image movement during exposure, and (2) the lens must be refocussed for the longer wave length of orange or red light. The lens is focussed within plus or minus .001 inches, and the automatic focus control compensates for variations in pressure and temperature in increments of .00136 inches per pound per square inch and .0009 inches per degree F. Thus, unnecessary refocussing of the lens in the field are regarded as risks that should be avoided.

3. Filter Factors of High Altitude Films

Films	Wratten Filter		
	12	21	25
3404	1.5	1.9	2.9
3400	1.9	2.4	4.0
3401	1.7	2.5	3.8

The filter factor is the number of times that you have to increase the exposure to compensate for the loss of light reaching the film. If .002 seconds gives the correct exposure for 3400 film with a wratten 12 filter then the exposure has to be more than doubled to use a wratten 25 filter.

4. Why use a filter?

A clean atmosphere is composed largely of nitrogen and oxygen molecules that are much smaller than the mean wavelength of visible light and would therefore have little effect on photographic recording. The real atmosphere contains larger particles of water, dust, smoke, pollen and similar aerosols whose size approximates or exceeds a wave length of light. Most of these particles are below 30,000' altitude. As sunlight passes through the atmosphere and is reflected back from the earth a complicated process of scattering attenuation, reflectance and absorption occurs. We are really concerned only with the image forming light that is reflected from the ground target and makes its way back through the atmosphere through a window off of two mirrors through a lens system and on to the film. As the relative humidity increases, more water particles are suspended in the air and more of the light is scattered going downward through the atmosphere and back as reflected light. The color of the scattered light is a function of the size of the particles in the atmosphere and is predominantly blue since the shorter wavelengths are scattered more than the longer (red) wavelengths. In aerial photography a yellow wratten 12 filter is used to reduce the effects of highly scattered blue light. When comparing the contrast of a ground scene with the contrast of the same scene viewed from 70,000' it is noted that a ground scene of 8 to 1 contrast (very high) drops to 5 to 1 with the solar altitude at 90° (directly over head) and down to 1.5 to one with a solar altitude of 40° at 70,000'. This is under ideal conditions with the target or ground scene directly below the aircraft. At offset distances of 35 to 45 miles the contrast of the scene at the camera is decreased by a factor of 3 by the presence of 3 times as much scatter due to the optical path being 3 times as long.

5. The lens in the "H" camera currently at Detachment H has a focal length of 66" and an aperture of F/5.6 however laboratory tests show that it produces better resolution when stopped down to F/7 which further reduces the amount of available light for recording imagry.

6. Since the H camera is a complex piece of equipment and is sensitive to pressure, temperature, and vehicle movement and requires careful pilotage to cover targets at large offsets, it is thought best not to introduce any new techniques that would involve the risk of reducing the current capability, particularly since there is only the single camera at Detachment H with no back up. Best results will be obtained at the highest solar altitude in the clearest weather with the sun nearly behind or in front of the aircraft permitting shadows to provide more contrast to the target scene. Some possibility exists of using a higher resolution film with smaller granularity such as 3404 or SO-243 however the light sensitivity of these films is 9 times less than 3400 currently being used. It is felt that these films might be used during the summer months (higher solar elevations) with the U-2R (more stable vehicle) and probably will require the use of one of the other two H cameras which can operate at the full aperture F/5.6 thus providing more useable light. These options will be explored at Detachment G to verify possible improvements. 25X1A

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